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Observations and Modelling of DQ White Dwarfs

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Abstract. We present spectropolarimetric observations and modelling of 12 DQ white dwarfs. Modelling is based on the method presented in Berdyugina et al. (2005). We use the model to fit the C2 absorption bands to get atmospheric parameters in different configurations, including stellar spots and stratified atmospheres, searching for the best possible fit. We still have problem to solve before we can give temperature estimates based on the Swan bands alone.

1. Introduction

We have observed 12 DQ white dwarfs to search for magnetic members in the class. Many of the few known peculiar DQs (Schmidt et al. 1999) and hot DQs (Dufour et al. 2007) are magnetic but the more numerous subclass, normal DQs had, until recently, only one magnetic member, G99-37. From our survey, we discovered that GJ841B is also magnetic and its properties closely resemble those of G99-37 (Vornanen et al. 2010).

Of the 12 stars GJ841B is the only clearly magnetic case. WD1235+422 also has a polarized spectrum but we haven't been able to model it with enough detail to say anything more about it.

2. Method

Figure 1 shows the intensity spectrum of GJ893.1 and the best fitting model that we could originally find. It is clear that the different molecular bands have wrong relative depths. However, the model has worked very well for CH features in G99-37 and GJ841B so it should work for C2 too. To improve the fit, we tried other physical configurations.

First, we explored a stellar spot. Figure 2 shows the resulting spectrum for a reasonable combination of spot and atmospheric temperatures. It is easy to see that a spot model does not improve the fit unless one uses different spot sizes for different absorption bands, which is unrealistic.

Next, we tried a stratified atmosphere. We allowed for three different layers, each with a different temperature and carbon abundance. The resulting fit is already a little bit better (See Fig. 3) but the relative depths of the Swan bands still differ. The best fitting model combinations are, however, unrealistic. Temperatures of 2000-3000 K are favored and this is too low for a white dwarf according to the current understanding.

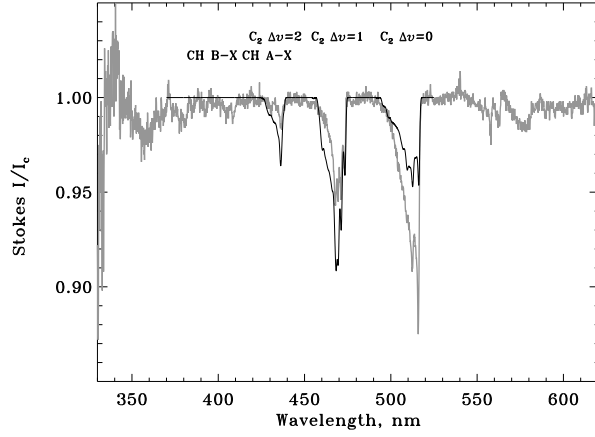


Figure 1. GJ893.1 first modelling.

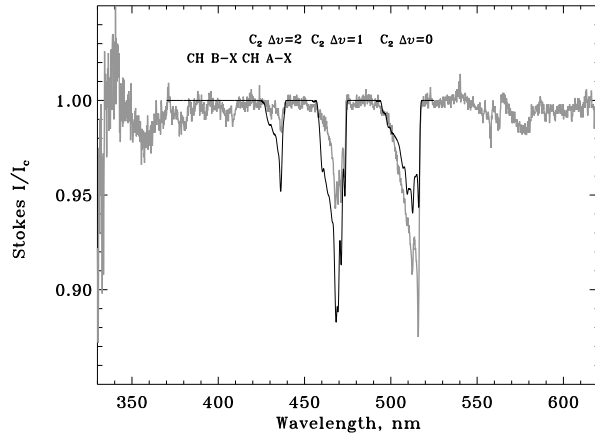


Figure 2. Spot model for GJ893.1.

Finally, we decided to modify the oscillator strengths of C2 to get a better fit. These parameters control the amount of absorption from each transition in the molecule. The values are determined in a laboratory, so changing them is a bit dubious, but the resulting fit is very good compared to the previous ones (Fig. 4). We also increased the maximum value of the total angular momentum quantum number J for the C₂ molecule. This is responsible for the better fits in the blue wing of the absorption bands.

3. Results

Figure 5 shows model fits for the non-magnetic DQ WDs in our survey as well as WD1235+422, which might be magnetic. Atomic lines in GJ1117 affect the automated fitting process and the best fit is actually very poor for that star.

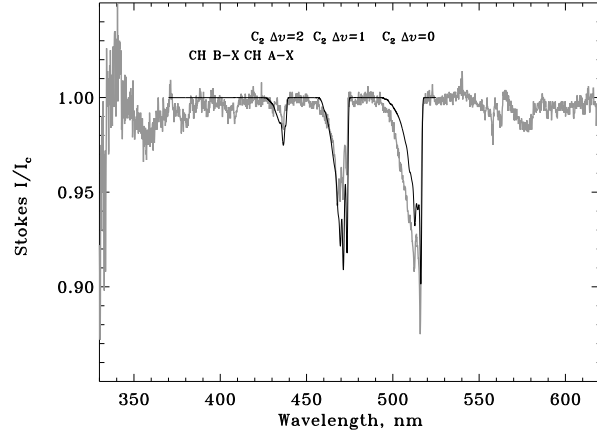


Figure 3. Stratified atmosphere with three layers.

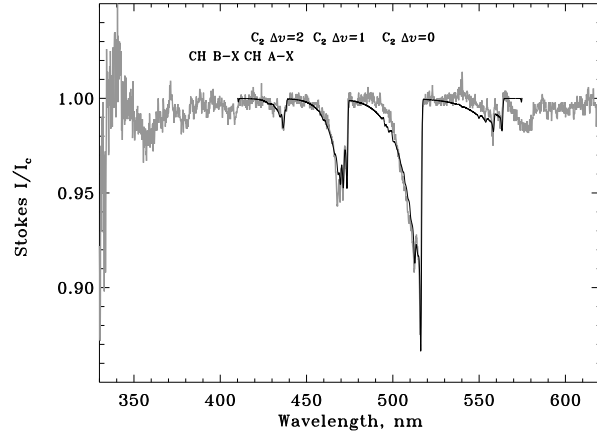


Figure 4. Final fit for GJ893.1 with modified oscillator strengths.

4. Obstacle

One problem remains, however. There is a free parameter in the code that controls the strengths of the individual absorption lines. This number is used to multiply the line profile to modify its depth. The parameter must be connected with a physical parameter (probably carbon abundance) and once that connection is found, we can provide temperature estimates for these white dwarfs based on our model.

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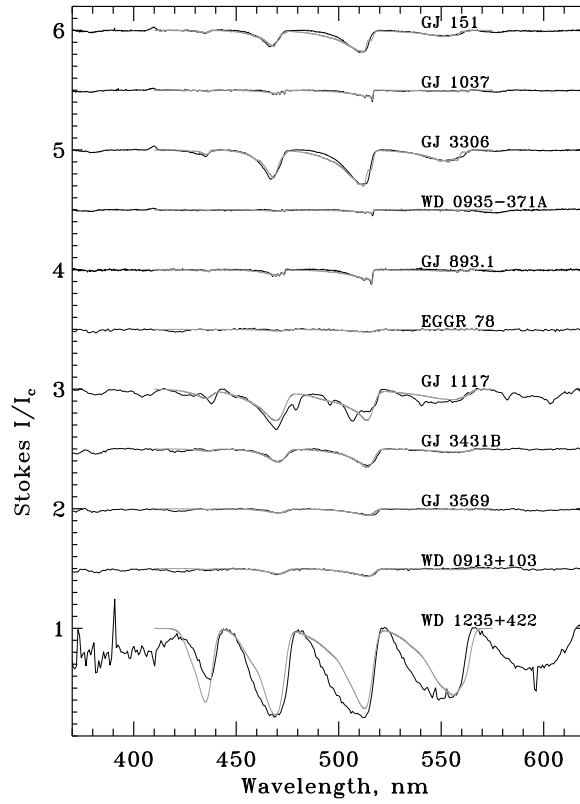


Figure 5. Observed spectra and best fitting models for our survey targets excluding GJ841B.

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